US009400114B2

(12) United States Patent
Melton et al.

(10) Patent No.: US 9,400,114 B2
(45) Date of Patent: Jul. 26, 2016

(54) **COMBUSTOR SUPPORT ASSEMBLY FOR MOUNTING A COMBUSTION MODULE OF A GAS TURBINE**

(71) Applicant: **General Electric Company**, Schenectady, NY (US)

(72) Inventors: **Patrick Benedict Melton**, Horse Shoe, NC (US); **Lucas John Stoia**, Taylors, SC (US); **Richard Martin DiCintio**, Simpsonville, SC (US); **Christopher Paul Willis**, Liberty, SC (US)

(73) Assignee: **GENERAL ELECTRIC COMPANY**, Schenectady, NY (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 630 days.

(21) Appl. No.: **13/845,699**

(22) Filed: **Mar. 18, 2013**

(65) **Prior Publication Data**

US 2014/0260319 A1 Sep. 18, 2014

(51) **Int. Cl.**

F23R 3/60 (2006.01)
F23R 3/34 (2006.01)
F23R 3/00 (2006.01)

(52) **U.S. Cl.**

CPC . ***F23R 3/60*** (2013.01); ***F23R 3/005*** (2013.01); *F23R 3/34* (2013.01); *F23R 2900/00017* (2013.01); *F23R 2900/00019* (2013.01)

(58) **Field of Classification Search**

CPC F23R 3/60; F23R 2900/00017; F23R 2900/00019; F23R 3/34; F23R 3/286
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,872,664	A	3/1975	Lohmann
4,265,615	A	5/1981	Lohmann
4,420,929	A	12/1983	Jorgensen
5,069,029	A	12/1991	Kuroda
5,380,154	A	1/1995	Norton
5,450,725	A	9/1995	Takahara
5,475,979	A	12/1995	Oag
5,802,854	A	9/1998	Maeda

(Continued)

FOREIGN PATENT DOCUMENTS

EP	0526058	A1	3/1993
EP	0578461	A1	12/1994
EP	1884297	A1	2/2008

OTHER PUBLICATIONS

Co-Pending U.S. Appl. No. 13/845,439, dated Mar. 18, 2013.

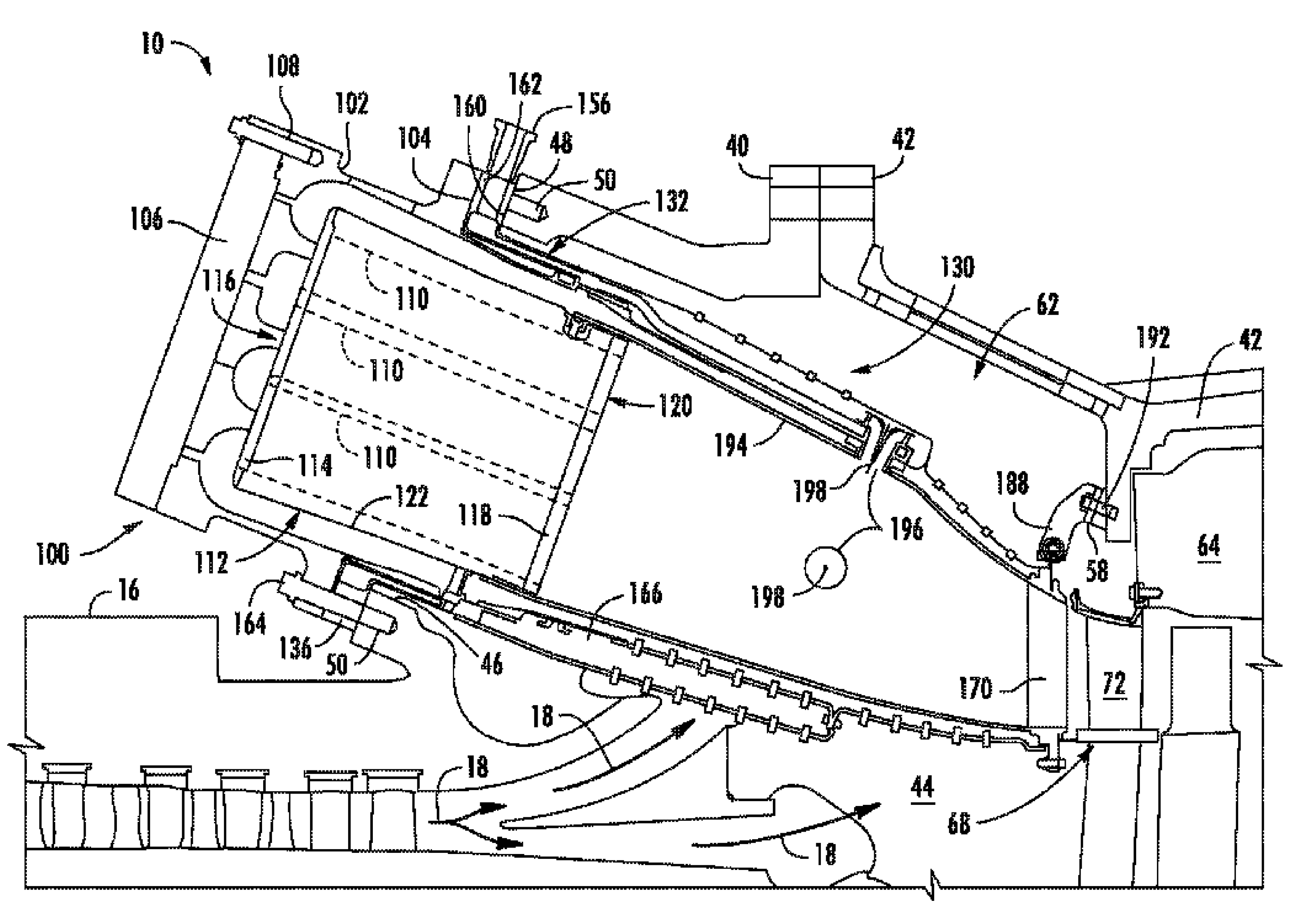
(Continued)

Primary Examiner — Gerald L Sung
Assistant Examiner — Thomas Burke
(74) *Attorney, Agent, or Firm* — Dority & Manning, PA

(57) **ABSTRACT**

A gas turbine comprises a compressor discharge casing that is coupled to an outer turbine shell. The compressor discharge casing includes a combustor opening that extends through the compressor discharge casing and an outer mating surface that circumferentially surrounds the combustor opening. The outer turbine shell defines an inner mating surface. A combustion module extends through the combustor opening. The combustion module includes a forward end that is circumferentially surrounded by a mounting flange and an aft end that is circumferentially surrounded by an aft frame. The mounting flange extends circumferentially around the combustor opening. The mounting flange is coupled to the outer mating surface of the compressor discharge casing and the aft frame is coupled to the inner mating surface of the outer turbine shell.

9 Claims, 6 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,047,550	A	4/2000	Beebe	
6,148,604	A	11/2000	Salt	
6,212,870	B1	4/2001	Thompson et al.	
6,374,594	B1	4/2002	Kraft et al.	
6,442,946	B1	9/2002	Kraft	
6,450,762	B1	9/2002	Munshi	
6,543,993	B2	4/2003	Burdgick et al.	
6,654,710	B1	11/2003	Keller	
6,875,009	B2	4/2005	Kayahara et al.	
6,896,509	B2	5/2005	Carroni et al.	
6,957,949	B2	10/2005	Hyde et al.	
7,082,766	B1	8/2006	Widener et al.	
7,743,612	B2	6/2010	Morenko	
8,096,131	B2	1/2012	Ziaei et al.	
8,158,428	B1	4/2012	Krishna	
8,171,738	B2	5/2012	Fish et al.	
2002/0184893	A1	12/2002	Farmer	
2003/0039542	A1	2/2003	Cromer	
2005/0044855	A1	3/2005	Crawley	
2005/0241317	A1	11/2005	Martling	
2005/0268617	A1 *	12/2005	Amond, III	F02C 9/34 60/776
2006/0230763	A1 *	10/2006	Johnson	F23R 3/10 60/740
2007/0089425	A1 *	4/2007	Motter	F02C 3/30 60/775
2008/0282667	A1	11/2008	Intile	
2009/0071157	A1	3/2009	Cai	
2009/0199561	A1	8/2009	Hessler	
2010/0005803	A1 *	1/2010	Tu	F01D 9/023 60/752
2010/0054928	A1	3/2010	Schiavo	
2010/0071377	A1	3/2010	Fox	
2010/0139283	A1	6/2010	Phillips et al.	
2010/0170216	A1	7/2010	Venkataraman	
2010/0170251	A1 *	7/2010	Davis, Jr.	F02C 7/228 60/740
2010/0174466	A1	7/2010	Davis, Jr. et al.	
2010/0263386	A1 *	10/2010	Edwards	F23R 3/60 60/796
2011/0067402	A1 *	3/2011	Wiebe	F23R 3/08 60/740
2011/0146284	A1	6/2011	Morimoto	
2011/0247314	A1	10/2011	Chila	
2011/0304104	A1	12/2011	McMahan	
2011/0314823	A1 *	12/2011	Smith	F23R 3/002 60/737
2012/0169326	A1 *	7/2012	Krishna	F23M 5/02 324/240
2012/0186260	A1	7/2012	DiCintio et al.	
2012/0210729	A1	8/2012	Cihlar et al.	
2012/0304648	A1 *	12/2012	Byrne	F23R 3/06 60/737
2014/0033728	A1	2/2014	Marmilic	
2014/0116066	A1 *	5/2014	Melton	F23R 3/28 60/806
2014/0260272	A1	9/2014	DiCintio	

OTHER PUBLICATIONS

Co-Pending U.S. Appl. No. 13/845,365, dated Mar. 18, 2013.
Co-Pending U.S. Appl. No. 13/845,485, dated Mar. 18, 2013.
Co-Pending U.S. Appl. No. 13/845,565, dated Mar. 18, 2013.
Co-Pending U.S. Appl. No. 13/845,617, dated Mar. 18, 2013.
Co-Pending U.S. Appl. No. 13/845,661, dated Mar. 18, 2013.
Co-Pending U.S. Appl. No. 13/845,384, dated Mar. 18, 2013.
Co-Pending U.S. Appl. No. 13/845,378, dated Mar. 18, 2013.

* cited by examiner

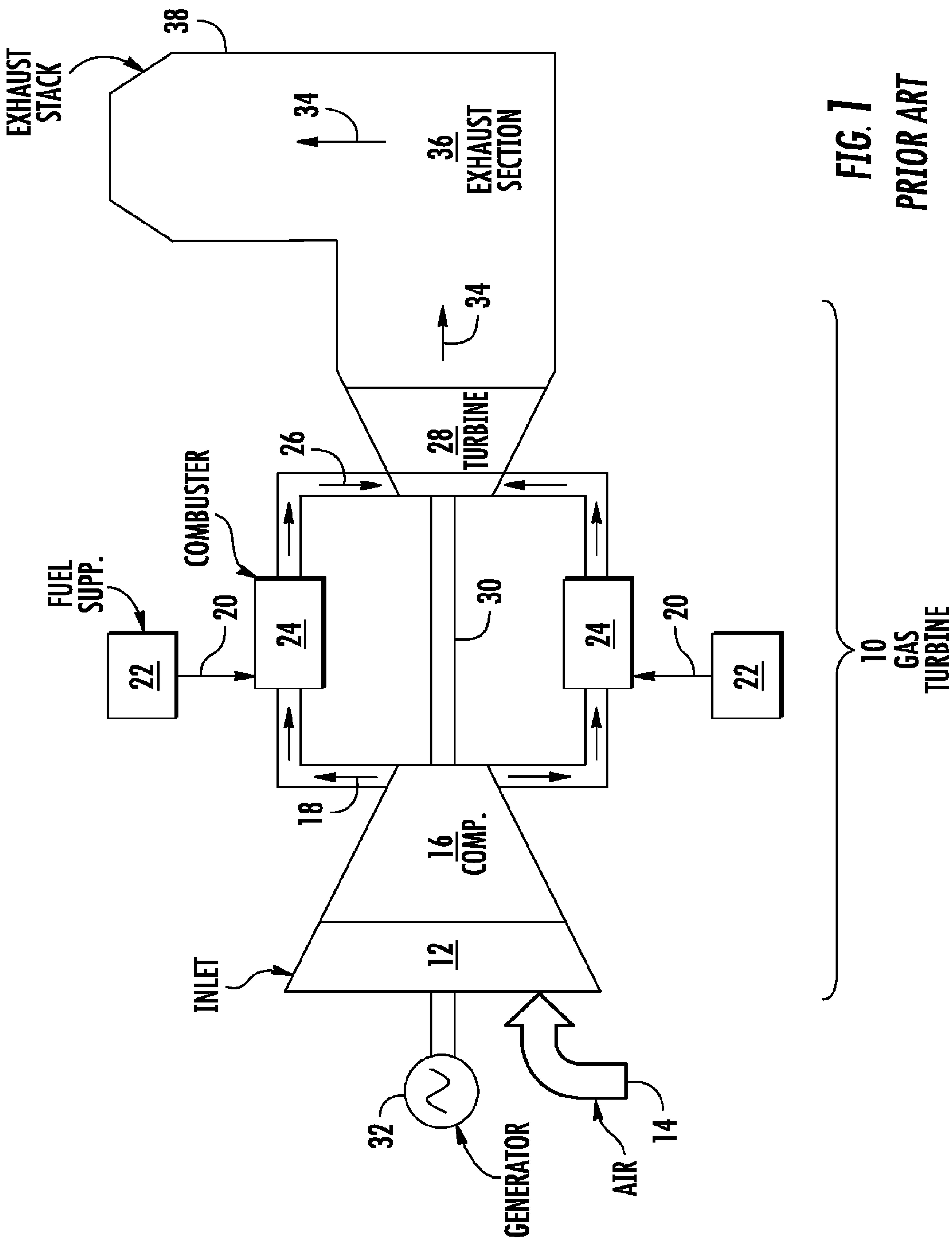


FIG. 1
PRIOR ART

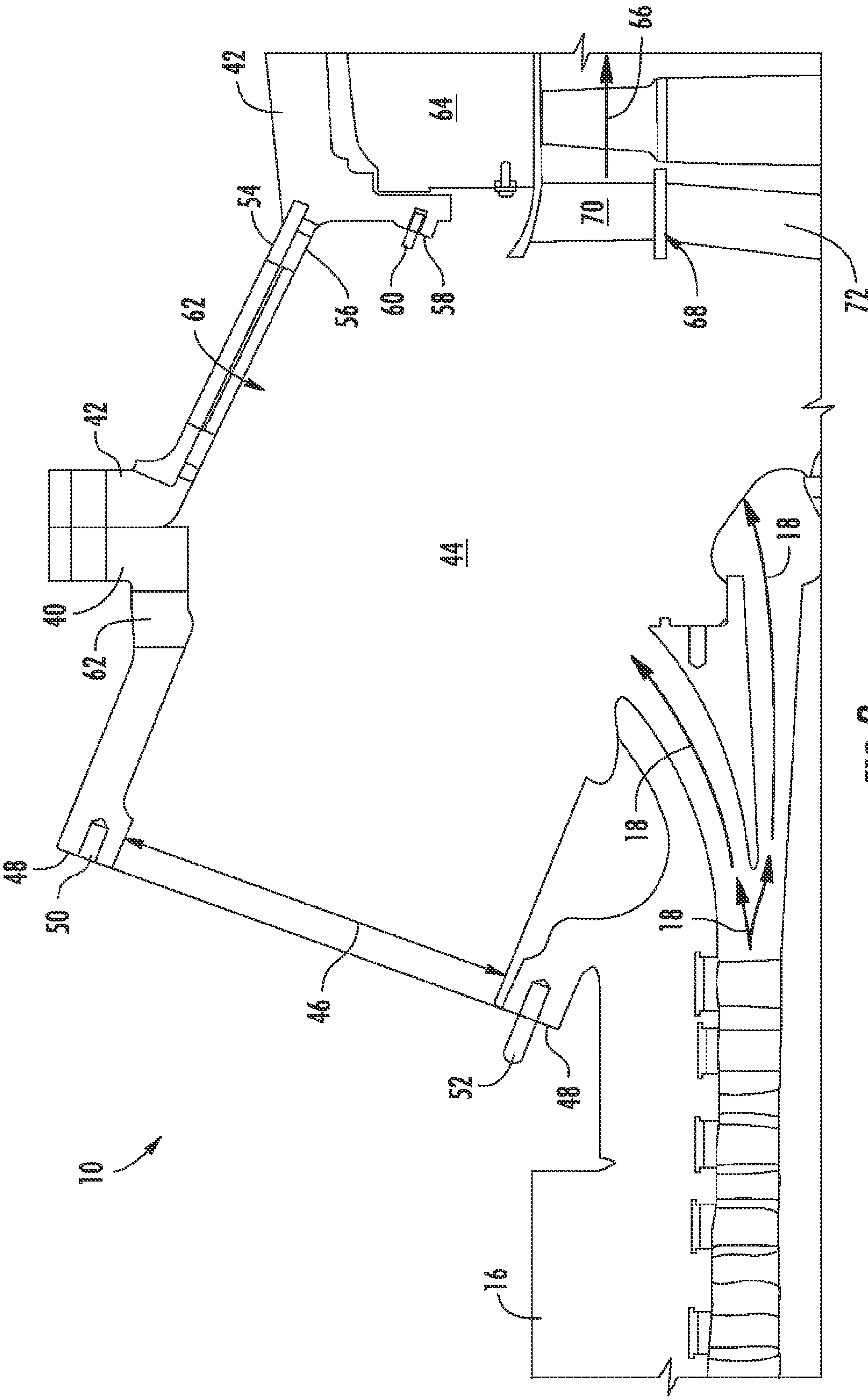

42
66
64
54
70
60
58
56
68
72
62
42
44
18
40
62
18
48
50
18
46
52
48
10
16

FIG. 2

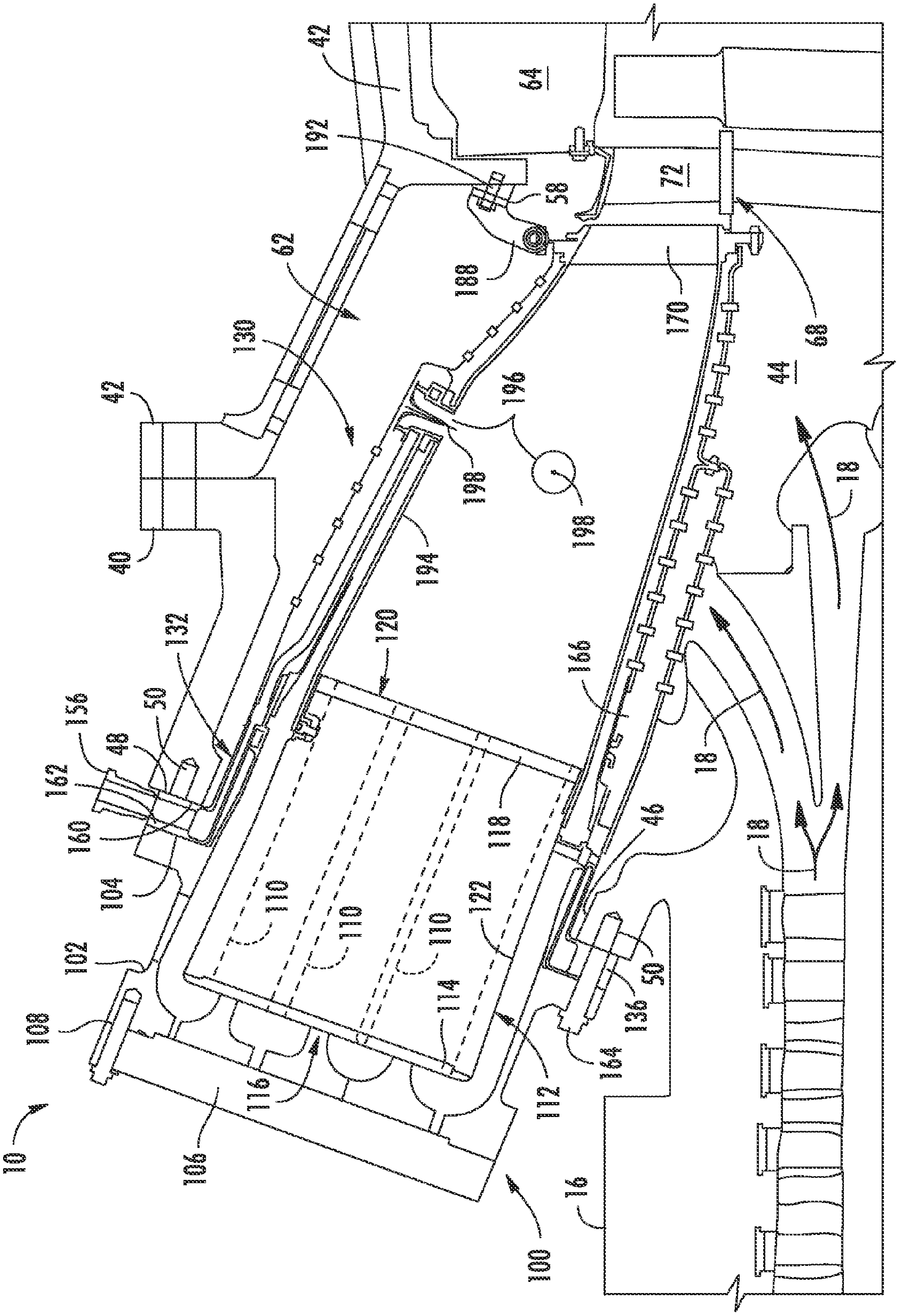

10
16
18
18
18
18
40
42
42
44
46
48
50
50
58
62
64
68
72
100
102
104
106
108
110
110
110
112
114
116
118
120
122
130
132
136
156
160
162
164
166
170
188
192
194
196
198
198

FIG. 3

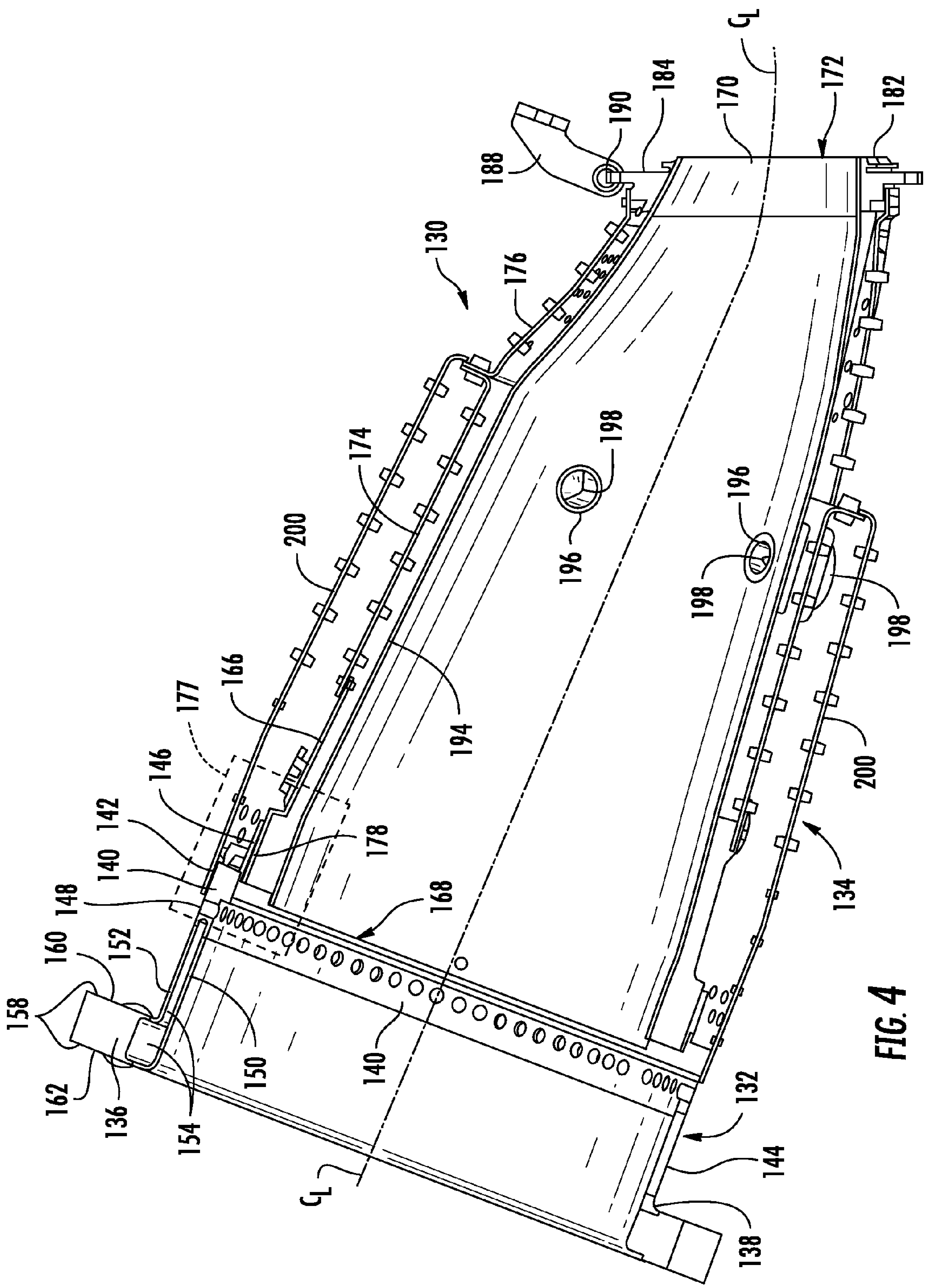

130
132
134
136
138
140
142
144
146
148
150
152
154
158
160
162
166
168
170
172
174
176
177
178
182
184
188
190
194
196
198
200
CL

FIG. 4

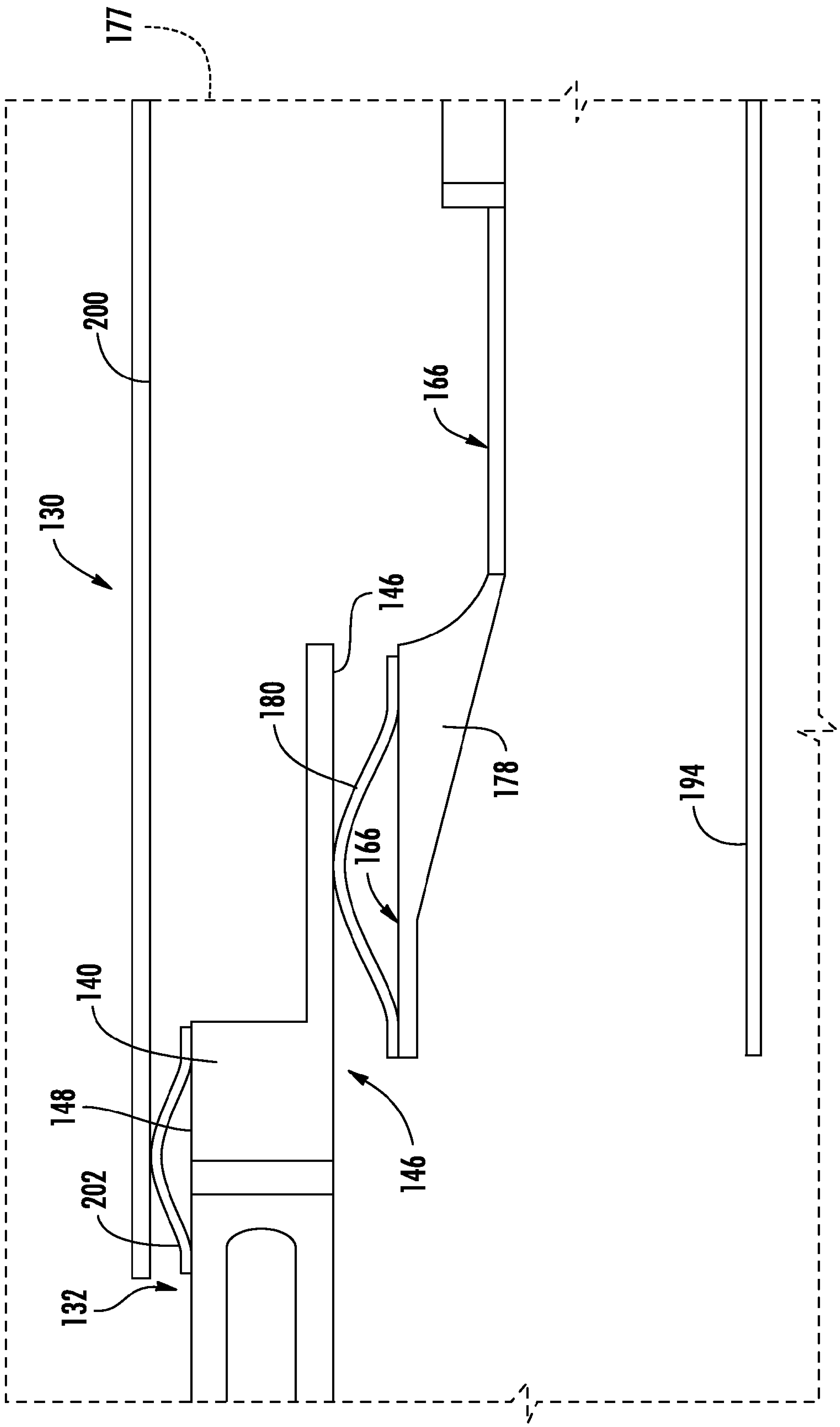


FIG. 5

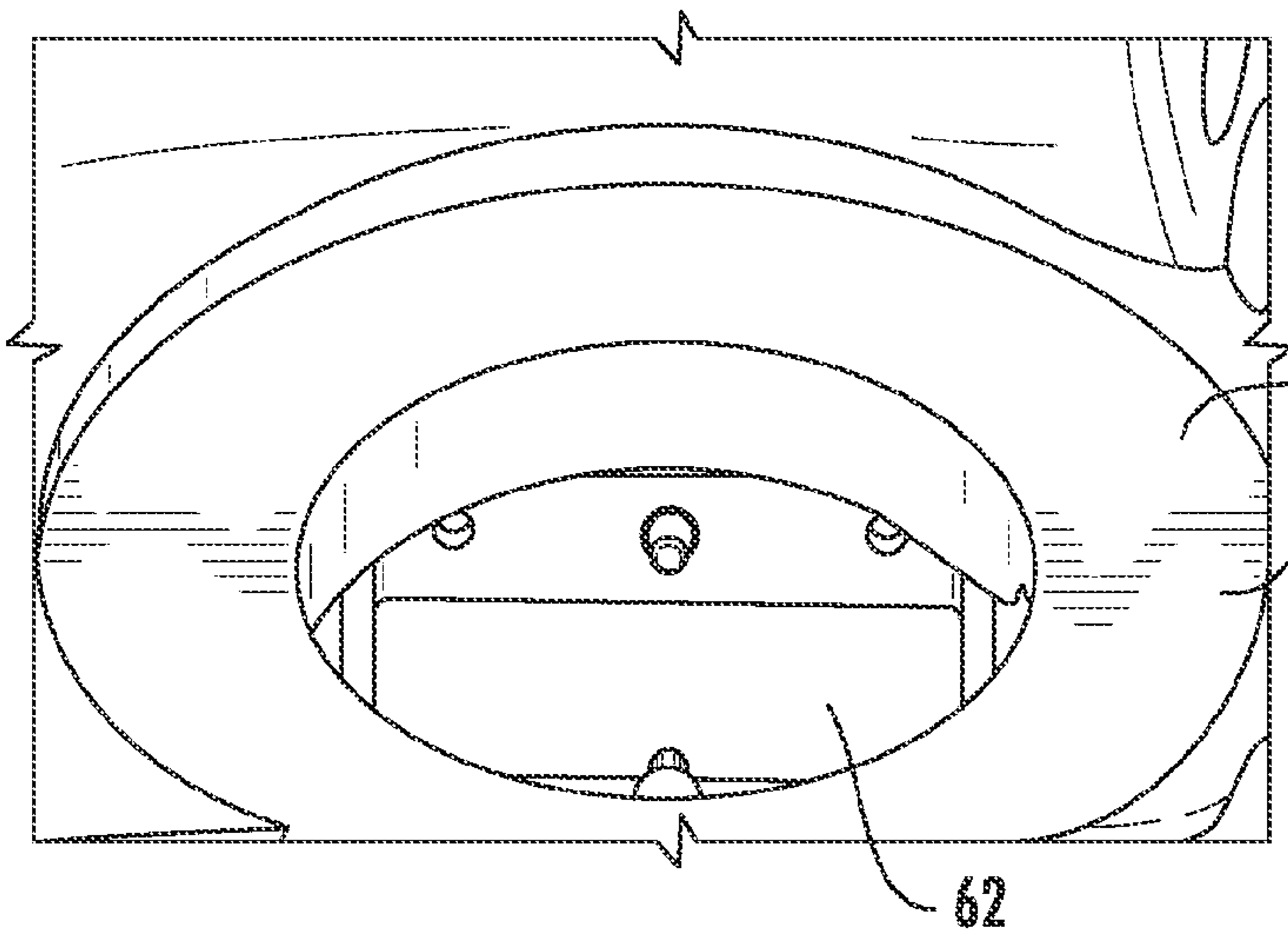


FIG. 6

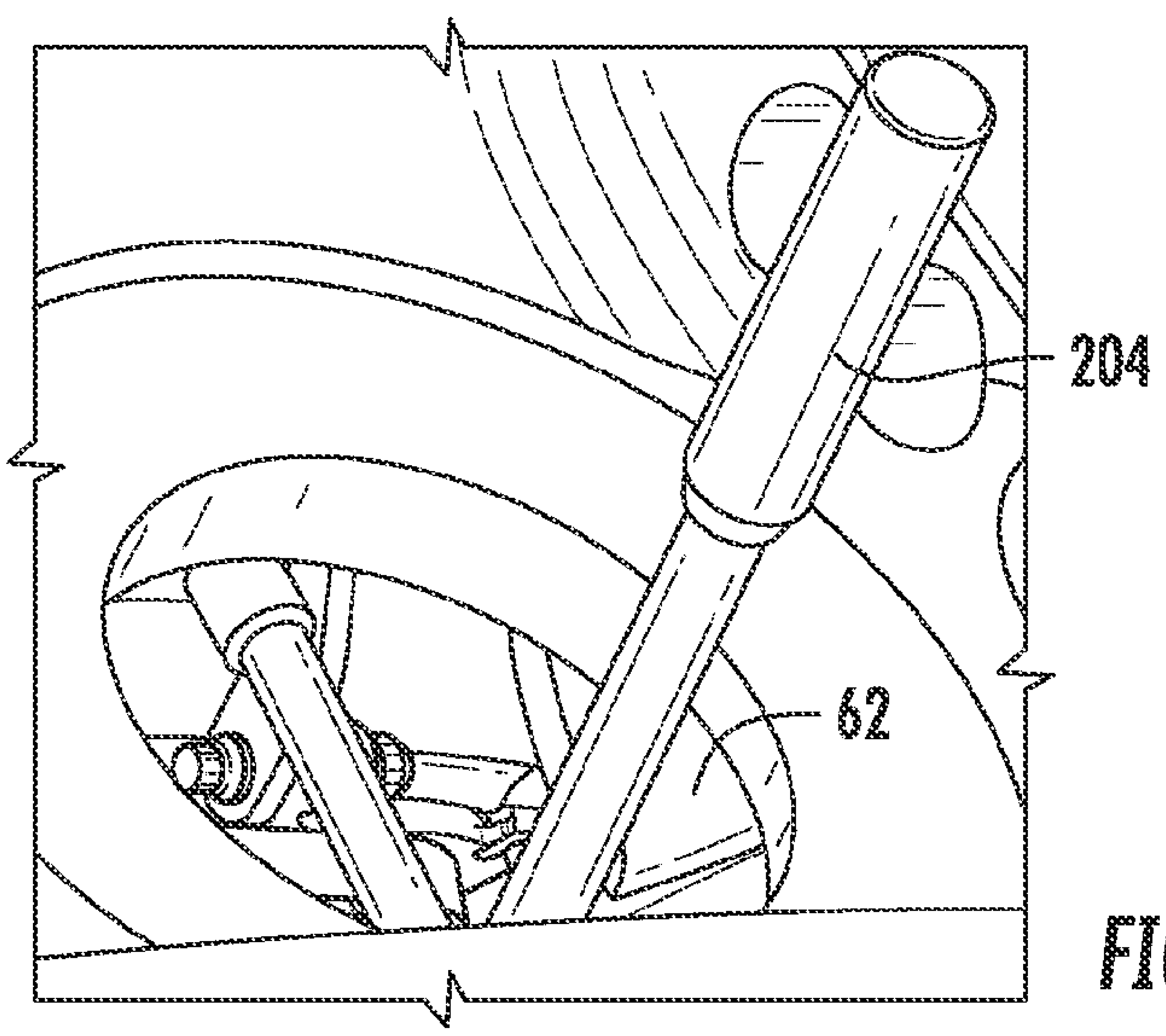


FIG. 7

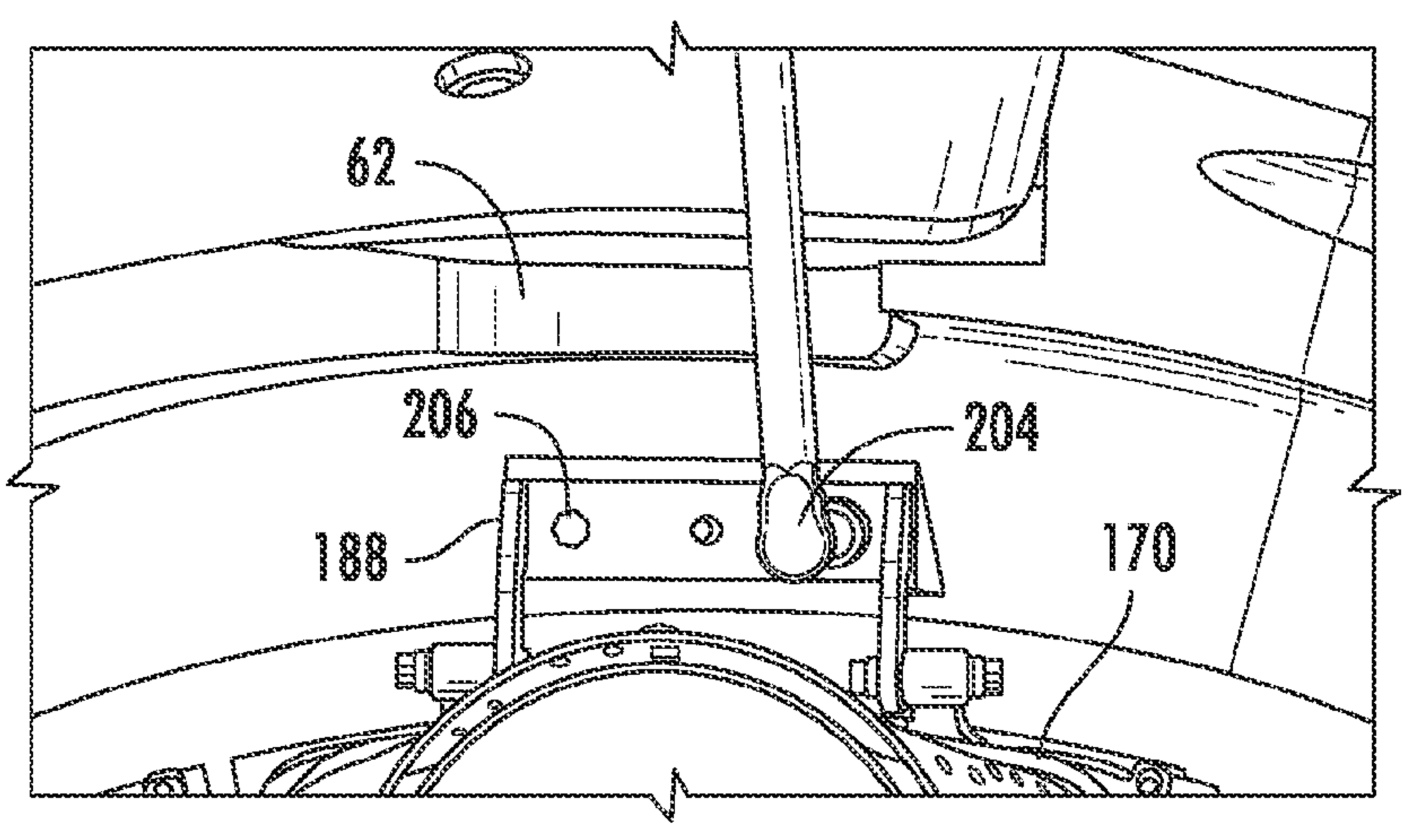


FIG. 8

COMBUSTOR SUPPORT ASSEMBLY FOR MOUNTING A COMBUSTION MODULE OF A GAS TURBINE

FIELD OF THE INVENTION

The present invention generally involves a gas turbine. More specifically, the invention relates to a combustor support assembly for mounting a combustion module to a gas turbine.

BACKGROUND OF THE INVENTION

Combustors are commonly used in industrial and power generation operations to ignite fuel to produce combustion gases having a high temperature and pressure. For example, turbo-machines such as gas turbines typically include one or more combustors to generate power or thrust. A typical gas turbine includes an inlet section, a compressor section, a combustion section, a turbine section, and an exhaust section. The inlet section cleans and conditions a working fluid (e.g., air) and supplies the working fluid to the compressor section. The compressor section increases the pressure of the working fluid and supplies a compressed working fluid to the combustion section. The compressed working fluid and a fuel are mixed within the combustion section and burned to generate combustion gases having a high temperature and pressure. The combustion gases flow to the turbine section where they expand to produce work. For example, expansion of the combustion gases in the turbine section may rotate a shaft connected to a generator to produce electricity.

The combustion section generally includes at least one combustor. A typical combustor includes an end cover coupled to a compressor discharge casing, an annular cap assembly that extends radially and axially within the compressor discharge casing, an annular liner that extends downstream from the cap assembly, and a transition piece that extends between the liner and a first stage of stationary nozzles that are positioned generally adjacent to an inlet to the turbine section.

In a common mounting scheme, a forward end of the liner circumferentially surrounds an aft end portion of the cap assembly. A spring seal or hula seal extends circumferentially around the aft end portion of the cap assembly and radially between the cap assembly and the forward end of the liner to provide a seal therebetween and/or to provide mounting support to the forward end of the liner. A forward end of the transition piece circumferentially surrounds an aft end of the liner. A spring seal or hula seal extends circumferentially around the aft end of the liner and radially between the liner and the forward end of the transition piece to provide a seal therebetween and/or to provide mounting support to the aft end of the liner. An aft frame portion of the transition piece is coupled to a turbine casing. In addition or in the alternative, a mounting bracket is or may be used to couple a bottom portion of the transition piece to the compressor discharge casing. In this mounting scheme, the transition piece is utilized to constrain the liner within the combustor. Although this mounting scheme is generally effective, it is not practical for newer and more compact gas turbine designs.

In continued efforts to decrease the overall size or footprint of gas turbines, the outer circumference of the compressor discharge casing for certain gas turbines has been decreased. As a result, access to the combustor, particularly the bottom portion of the transition piece and or the liner during installation and removal of the combustor has been restricted. In addition, in an effort to decrease the number of individual components within the combustor of the gas turbine, the transition piece and the combustion liner of certain gas turbine combustors have been combined into a single liner component that is at least partially surrounded by one or more flow sleeves and/or impingement sleeves. As a result, the existing mounting schemes are generally ineffective and/or impractical for mounting the newer combustor types within the smaller compressor discharge casing. Therefore, an improved combustor support assembly for mounting a combustion module of a gas turbine would be useful.

BRIEF DESCRIPTION OF THE INVENTION

Aspects and advantages of the invention are set forth below in the following description, or may be obvious from the description, or may be learned through practice of the invention.

One embodiment of the present invention is a combustor support assembly for a gas turbine. The combustion module generally includes a compressor discharge casing that is coupled to an outer turbine shell. The compressor discharge casing includes a combustor opening that extends through the compressor discharge casing and an outer mating surface that circumferentially surrounds the combustor opening. The outer turbine shell defines an inner mating surface. A combustion module extends through the combustor opening. The combustion module includes a forward end that is circumferentially surrounded by a mounting flange and an aft end that is circumferentially surrounded by an aft frame. The mounting flange extends circumferentially around the combustor opening. The mounting flange is coupled to the outer mating surface of the compressor discharge casing and the aft frame is coupled to the inner mating surface of the outer turbine shell.

Another embodiment of the present invention is a combustor support assembly for a gas turbine. The combustor support assembly includes a compressor discharge casing that is coupled to an outer turbine shell. The compressor discharge casing has a combustor opening that extends through the compressor discharge casing and an outer mating surface that circumferentially surrounds the combustor opening. The outer turbine shell defines an inner mating surface. An annular fuel distribution manifold extends through the combustor opening. The fuel distribution manifold includes a forward end and an aft end. The fuel distribution manifold has a mounting flange at the forward end and an annular support ring at the aft end. The support ring has an inner support portion. A fuel injection assembly extends downstream from the fuel distribution manifold. The fuel injection assembly includes a forward end and an aft end. The fuel injection assembly comprises an annular support sleeve that is disposed at the forward end and an aft frame that is disposed at the aft end. The support sleeve includes a forward end that is at least partially surrounded by the inner support portion of the support ring. The mounting flange of the fuel distribution manifold is coupled to the outer mating surface of the compressor discharge casing. The aft frame of the fuel injection assembly is coupled to the inner mating surface of the outer turbine shell.

The present invention may also include a combustor support assembly for a gas turbine having a compressor discharge casing coupled to an outer turbine shell. The compressor discharge casing includes a combustor opening that extends through the compressor discharge casing and an outer mating surface that circumferentially surrounds the combustor opening. The outer turbine shell defines an inner mating surface. An annular fuel distribution manifold extends through the combustor opening. The fuel distribution manifold has a mounting flange at a forward end and an annular support ring disposed at an aft end. The mounting flange defines a first mating surface that is axially separated from a second mating surface. The support ring includes an inner support portion. A fuel injection assembly extends downstream from the fuel distribution manifold. The fuel injection assembly has a forward end and an aft end. The fuel injection assembly includes an annular support sleeve that is disposed at the forward end and an aft frame that is disposed at the aft end. The support sleeve is coupled to the aft frame by at least one of an annular flow sleeve or an annular impingement sleeve. The support sleeve includes a forward end that is at least partially surrounded by the inner support portion of the support ring. An annular spacer casing has a radially extending end cover disposed at a first end and a flange at a second end. The flange is coupled to the second mating surface of the mounting flange. The annular spacer casing and the mounting flange are coupled to the outer mating surface of the compressor discharge casing. The aft frame of the fuel injection assembly is coupled to the inner mating surface of the outer turbine shell.

Those of ordinary skill in the art will better appreciate the features and aspects of such embodiments, and others, upon review of the specification.

BRIEF DESCRIPTION OF THE DRAWINGS

A full and enabling disclosure of the present invention, including the best mode thereof to one skilled in the art, is set forth more particularly in the remainder of the specification, including reference to the accompanying figures, in which:

FIG. **1** is a functional block diagram of an exemplary gas turbine within the scope of the present invention;

FIG. **2** is a cross-section side view of a portion of an exemplary gas turbine according to various embodiments of the present invention;

FIG. **3** is a cross-section side view of a portion of the gas turbine as shown in FIG. **2** including a combustor, according to various embodiments of the present invention;

FIG. **4** is an enlarged cross-section side view of a combustion module of the combustor as shown in FIG. **3**, according to at least one embodiment of the present disclosure;

FIG. **5** is an enlarged view of a portion of the combustion module a shown in FIG. **4**, according to at least one embodiment of the present disclosure;

FIG. **6** is an enlarged perspective view of a portion of the gas turbine as shown in FIG. **3**, according to at least one embodiment of the present disclosure;

FIG. **7** is an enlarged perspective view of a portion of the gas turbine as shown in FIG. **3**, according to at least one embodiment of the present disclosure; and

FIG. **8** is an enlarged perspective view of a portion of the gas turbine as shown in FIG. **3**, according to at least one embodiment of the present disclosure.

DETAILED DESCRIPTION OF THE INVENTION

Reference will now be made in detail to present embodiments of the invention, one or more examples of which are illustrated in the accompanying drawings. The detailed description uses numerical and letter designations to refer to features in the drawings. Like or similar designations in the drawings and description have been used to refer to like or similar parts of the invention. As used herein, the terms "first", "second", and "third" may be used interchangeably to distinguish one component from another and are not intended to signify location or importance of the individual components. The terms "upstream" and "downstream" refer to the relative direction with respect to fluid flow in a fluid pathway. For example, "upstream" refers to the direction from which the fluid flows, and "downstream" refers to the direction to which the fluid flows. The term "radially" refers to the relative direction that is substantially perpendicular to an axial centerline of a particular component, and the term "axially" refers to the relative direction that is substantially parallel to an axial centerline of a particular component.

Each example is provided by way of explanation of the invention, not limitation of the invention. In fact, it will be apparent to those skilled in the art that modifications and variations can be made in the present invention without departing from the scope or spirit thereof. For instance, features illustrated or described as part of one embodiment may be used on another embodiment to yield a still further embodiment. Thus, it is intended that the present invention covers such modifications and variations as come within the scope of the appended claims and their equivalents. Although exemplary embodiments of the present invention will be described generally in the context of a combustor incorporated into a gas turbine for purposes of illustration, one of ordinary skill in the art will readily appreciate that embodiments of the present invention may be applied to any combustor incorporated into any turbomachine and is not limited to a gas turbine combustor unless specifically recited in the claims.

Referring now to the drawings, wherein identical numerals indicate the same elements throughout the figures, FIG. **1** provides a functional block diagram of an exemplary gas turbine **10** that may incorporate various embodiments of the present invention. As shown, the gas turbine **10** generally includes an inlet section **12** that may include a series of filters, cooling coils, moisture separators, and/or other devices to purify and otherwise condition a working fluid (e.g., air) **14** entering the gas turbine **10**. The working fluid **14** flows to a compressor section where a compressor **16** progressively imparts kinetic energy to the working fluid **14** to produce a compressed working fluid **18** at a highly energized state.

The compressed working fluid **18** is mixed with a fuel **20** from a fuel supply **22** to form a combustible mixture within one or more combustors **24**. The combustible mixture is burned to produce combustion gases **26** having a high temperature and pressure. The combustion gases **26** flow through a turbine **28** of a turbine section to produce work. For example, the turbine **28** may be connected to a shaft **30** so that rotation of the turbine **28** drives the compressor **16** to produce the compressed working fluid **18**. Alternately or in addition, the shaft **30** may connect the turbine **28** to a generator **32** for producing electricity. Exhaust gases **34** from the turbine **28** flow through an exhaust section **36** that connects the turbine **28** to an exhaust stack **38** downstream from the turbine **28**. The exhaust section **36** may include, for example, a heat recovery steam generator (not shown) for cleaning and extracting additional heat from the exhaust gases **34** prior to release to the environment.

FIG. **2** provides a cross-section side view of a portion of the gas turbine **10** according to various embodiments of the present disclosure. As shown, the gas turbine generally includes a compressor discharge casing **40** that is in fluid communication with the compressor **16**. An outer turbine casing or shell **42** is coupled to the compressor discharge casing **40**. The outer turbine shell **42** and the compressor discharge casing **40** at least partially define a high pressure plenum **44** that is in fluid communication with the compressor **16**.

The compressor discharge casing **40** at least partially defines a combustor opening **46** for installing a combustor (not shown) into the gas turbine **10**. The compressor discharge casing **40** at least partially defines an outer mating surface **48** that extends circumferentially around the combustor opening **46**. A plurality of fastener holes **50** extends through the outer mating surface **48** and into the compressor discharge casing **40**. The fastener holes **50** may be tapped and/or threaded to receive a fastener such as a bolt or a threaded insert. In particular embodiments, a guide pin **52** extends outward from the outer mating surface **48** of the compressor discharge casing **40**.

The outer turbine shell **42** includes an outer surface **54** and an inner surface **56**. In one embodiment, an inner mating surface **58** is at least partially defined by the inner surface **56**. In particular embodiments, a guide pin **60** extends from the inner mating surface **58**. In particular embodiments, a service access opening **62** such as an arm-way or a man-way extends through the outer turbine shell **42**. The service access opening **62** is positioned generally proximate to the inner mating surface **58** to allow for access to the inner mating surface **58** during installation and removal of the combustor **24** (not shown). In alternate embodiments, the service access opening **62** extends through the compressor discharge casing **40** in a manner that allows for access to the inner mating surface **58** during installation and removal of the combustor **24** (not shown).

In particular embodiments, an inner turbine shell **64** is at least partially surrounded by the outer turbine shell **42**. The inner turbine shell **64** at least partially defines a hot gas path **66** that extends through the turbine **28**. The inner turbine shell **64** may at least partially support a first stage **68** of a plurality of stationary nozzles **70**. For example, the plurality of stationary nozzles **70** may be coupled to the inner turbine shell **64**. In addition or in the alternative, the plurality of stationary nozzles **70** may be coupled to at least one nozzle support ring **72** that extends circumferentially within the high pressure plenum **44**.

FIG. **3** provides a cross-section side view of the portion of the gas turbine as shown in FIG. **2**, according to various embodiments of the present disclosure. As shown in FIG. **3**, a combustor **100** extends through the combustor opening **46** of the compressor discharge casing **40**. In particular embodiments, the combustor **100** includes an annular spacer casing **102**. An aft end **104** of the spacer casing **102** is coupled to the outer mating surface **48** of the compressor discharge casing **40**. A radially extending end cover **106** is disposed at a forward end **108** of the spacer casing **102**. One or more axially extending fuel nozzles **110** extend downstream from the end cover **106** within the spacer casing **102**.

In particular embodiments, the combustor **100** further includes a radially extending annular cap assembly **112**. The cap assembly **112** is disposed downstream from the end cover **106** and at least partially surrounds each and/or some of the one or more axially extending fuel nozzles **110**. The cap assembly **112** generally includes a radially extending base plate **114** that is disposed at an upstream end **116** of the cap assembly **112** that is generally adjacent to the end cover **106**, a radially extending cap plate **118** that is disposed at a downstream end **120** of the cap assembly **112**, and one or more annular shroud(s) **122** that extend at least partially between the base plate **114** and the cap plate **118**. The cap assembly **112** generally extends at least partially through the combustor opening **46** of the compressor discharge casing. A radially extending spring seal or hula seal (not shown) may at least partially circumferentially surround the downstream end **120** of the cap assembly **112**.

As shown in FIG. **3**, the combustor **100** includes a combustion module **130** that extends through the combustor opening **46** of the compressor discharge casing **40** and that terminates at a point that is generally adjacent to the first stage **68** of the plurality of stationary nozzles **72**. FIG. **4** provides a cross-section side view of the combustion module **130** as shown in FIG. **3**. In particular embodiments, as shown in FIG. **4** the combustion module **130** generally comprises an annular fuel distribution manifold **132** and a fuel injection assembly **134**. As shown in FIG. **3**, the cap assembly **122** extends at least partially through the fuel distribution manifold **132** towards the fuel injection assembly **134**. The fuel injection assembly **134** extends downstream from the fuel distribution manifold **132**.

In particular embodiments, the fuel distribution manifold **132** includes a mounting flange **136** that circumferentially surrounds an upstream or forward end **138** of the fuel distribution manifold **132**, an annular support ring **140** that circumferentially surrounds an aft or downstream end **142** of the fuel distribution manifold **132**, and an annular sleeve **144** that extends b**54**etween the mounting flange **136** and the support ring **140**. As shown in FIG. **4**, the support ring **140** generally includes an inner portion **146** radially separated from an outer portion **148**.

In particular embodiments, as shown in FIG. **5**, the fuel distribution manifold **132** includes an annular inner sleeve **150** and an annular outer sleeve **152** that extend between the mounting flange **136** and the support ring **140**. As shown, the outer sleeve **152** is radially separated from the inner sleeve **150** to at least partially define a fuel plenum **154** therebetween. In particular embodiments, as shown in FIG. **3**, the mounting flange **136** includes an inlet port **156**. The inlet port **156** may be in fluid communication with the fuel supply **22** (FIG. **1**) and/or with the fuel plenum **154**. As shown in FIG. **4**, the mounting flange **136** may at least partially define the fuel plenum **154**.

The mounting flange **136** generally includes a pair of opposing mating sides or surfaces **158**. The pair of opposing mating surfaces **158** generally comprises a first mating side or surface **160** that is axially separated from a second mating side or surface **162**. In particular embodiments, as shown in FIG. **3**, the first mating surface **160** is coupled to the outer mating surface **48** of the compressor discharge casing **40**. In further embodiments, the aft end **104** of the spacer casing **102** is coupled to the second mating surface **162**. A plurality of fasteners **164** extends through the aft end of the spacer casing **102** and/or the mounting flange **136** and into the fastener holes **50** disposed within the compressor discharge casing **40** to couple the fuel distribution manifold **132** to the outer mating surface **48** of the compressor discharge casing **40**.

As shown in FIG. **4**, the fuel injection assembly **134** generally includes an annular support sleeve **166** disposed proximate to a forward end **168** of the fuel injection assembly **134**, and an aft frame **170** that at least partially defines an aft end **172** of the fuel injection assembly **134**. In particular embodiments, as shown in FIG. **4**, the aft frame **170** is coupled to the support sleeve **166** by at least one of an annular flow sleeve **174** or an annular impingement sleeve **176** that extends at least partially between the aft frame **170** and the support sleeve **166**.

FIG. **5** provides an enlarged view of a portion of the combustion module **130** as outlined by dashed line **177**. As shown in FIG. **5**, a forward portion **178** of the support sleeve **166** is at least partially circumferentially surrounded by the inner portion **146** of the support ring **140**. In particular embodiments, a spring seal **180** such as a hula seal extends radially between the forward end **178** of the support sleeve **166** and the inner portion **146** of the support ring **140**. The spring seal **180** generally provides structural support between the fuel distribution manifold **132** and the fuel injection assembly **134** during installation and/or operation of the gas turbine **10**.

As shown in FIG. **4**, the aft frame **170** generally includes an inner portion **182** that is radially separated from an outer portion **184**. In particular embodiments, a mounting bracket **188** is coupled to the outer portion **184** of the aft frame **170** via a boss **190** or other coupling feature. The mounting bracket **188** may pivot about the boss **190** and/or may be fixed in position. For example, the mounting bracket **188** may pivot or rotate in a forward direction and/or aft direction with respect to an axial centerline of the combustion module **130**. In this manner, the position or orientation of the mounting bracket **188** may be manipulated before and/or during installation of the combustion module **130** to accommodate for tolerance stack up issues and/or to guide the combustion module **130** into position during installation into the gas turbine **10**. In addition, the mounting bracket **188** may pivot as the gas turbine **10** transitions between various thermal transient conditions such as during startup, shutdown and/or turndown operation. In one embodiment, as shown in FIG. **3**, an alignment feature **192** such as a guide pin extends from the mounting bracket **188**.

In particular embodiments, as shown in FIGS. **3**, **4** and **5**, the fuel injection assembly **134** further comprises an annular liner **194** such as a combustion liner or a transition duct that extends from the aft frame **170** towards the support sleeve **166**. As shown in FIGS. **3** and **4**, the liner **194** may at least partially define a fuel injector passage **196** that extends generally radially through the liner **194**. In particular embodiments, the liner **194** may define a plurality of the fuel injector passages **196**.

A fuel injector **198** may extend at least partially through the fuel injector passage **196**. In various embodiments, as shown in FIG. **4**, the fuel injection assembly **134** may further include an annular or semi annular outer flow sleeve **200** that circumferentially surrounds the flow sleeve **174** and/or the fuel injector **198**. As shown in FIG. **5**, a portion of the outer flow sleeve **200** circumferentially surrounds the outer portion **148** of the support ring **140**. In particular embodiments, a spring seal **202** such as a hula seal extends radially between the outer flow sleeve **200** and the outer portion **148** of the support ring **140**. The spring seal **202** generally provides structural support between the outer flow sleeve **200** and the fuel distribution manifold **132** during installation and operation of the combustion module **130**.

The various embodiments as shown in FIGS. **2** through **8** and as described herein provide for a combustor support assembly for mounting a combustion module of the gas turbine **10**. For example, according to one embodiment, as shown in FIG. **3**, the aft end **172** of the combustion module **130** is inserted through the combustor opening **46** in the compressor discharge casing **40**. The aft frame **170** and/or the mounting bracket **188** are aligned with the inner mating surface **58** of the outer turbine shell **42** using the alignment feature **192** and or by guiding the combustion module **130** into place through the service access opening **62**. In addition, jacking tools (not shown) may be used to align the combustion module **130** into position. The mounting flange **136** may be aligned to the outer mating surface **48** of the compressor discharge casing **40** via the guide pin **52**.

A tool **204** such as a pneumatic wrench may be inserted through the service access opening **62** to couple the mounting bracket **188** to the inner turbine shell **42**. The cap assembly **112** may be inserted through the combustor opening **46** and mounted to the combustor **100** so that the downstream end **120** of the cap assembly **112** circumferentially surrounds a portion of the liner **194**. The end cover **106** and the spacer casing **102** are positioned such that the aft end **104** of the spacer casing **102** is adjacent to the second mating surface **162** of the mounting flange **136**. The spacer casing **102** is coupled to the second mating surface **162** of the mounting flange **136** and the compressor discharge casing **40** by the plurality of the fasteners **164**. In this manner, the combustion module **130** is constrained at both the combustor opening **46** and at the aft frame **170**.

This written description uses examples to disclose the invention, including the best mode, and also to enable any person skilled in the art to practice the invention, including making and using any devices or systems and performing any incorporated methods. The patentable scope of the invention is defined by the claims, and may include other examples that occur to those skilled in the art. Such other examples are intended to be within the scope of the claims if they include structural elements that do not differ from the literal language of the claims, or if they include equivalent structural elements with insubstantial differences from the literal language of the claims.

What is claimed is:

1. A combustor support assembly, comprising:

a turbine including an outer turbine casing circumferentially surrounding an inner turbine casing, the outer turbine casing defining an inner mating surface;

a compressor discharge casing coupled to the outer turbine casing and defining a combustor opening;

a combustion module comprising:

an annular mounting flange connected to the compressor discharge casing and an annular support ring coupled to the mounting flange and extending through the combustor opening into the compressor discharge casing;

an aft frame disposed at a downstream end of the combustion module, the aft frame having a mounting bracket disposed along an outer portion of the aft frame, the aft frame rigidly connected to the mating surface of the outer turbine casing via the mounting bracket;

an annular flow sleeve having a forward portion at least partially surrounded by a portion of the support ring and an aft portion coupled to the aft frame;

an outer flow sleeve connected to an outer surface of the annular flow sleeve, wherein the outer flow sleeve comprises an upstream end portion that extends circumferentially around an outer surface of the support ring, wherein the outer flow sleeve moves axially with respect to the support ring; and

a first spring seal that extends radially between an inner surface of the support ring and the outer surface of the annular flow sleeve, wherein the annular flow sleeve moves axially with respect to the support ring.

2. The combustor support assembly as in claim **1**, further comprising a guide pin that extends outwardly from the inner mating surface of the outer turbine casing.

3. The combustor support assembly as in claim **1**, wherein the aft frame moves with the outer turbine casing independent of the inner turbine casing.

4. The combustor support assembly as in claim **1**, wherein the aft frame is secured in position at a single connection point within the outer turbine casing via the mounting bracket.

5. The combustor support assembly as in claim **1**, further comprising a second spring seal that extends radially between the outer surface of the support ring and an inner surface of the outer flow sleeve.

6. The combustor support assembly as in claim **1**, wherein at least one of the outer turbine casing and the compressor discharge casing defines a service access opening proximate to the mounting bracket.

7. The combustor support assembly as in claim **1**, wherein the mounting flange defines a fuel plenum therein.

8. The combustor support assembly as in claim **1**, Wherein the support ring defines a fuel plenum therein.

9. The combustor support assembly as in claim **1**, wherein the combustion module further comprises an annular liner that extends axially within the flow sleeve, wherein a downstream end of the liner is coupled to the aft frame and an upstream end portion of the liner is circumferentially surrounded by the forward portion of the flow sleeve.

* * * * *